
CLAIMS

[Claim(s)]
1. It is joined to the underside of the insulating substrate joined to the rear face of the vibrator formed in the same substrate as a supporter so that it might be supported in the condition that an end can vibrate freely to a supporter, and said substrate, and said insulating substrate, and has a piezoelectric device. In the gyroscope sensor which vibrates said trembler in the thickness direction by said piezoelectric device Slot which has the slant face established in said trembler Gyroscope sensor characterized by preparing a piezo-electric thin film in the slant face of said slot.
2. It is joined to the underside of the insulating substrate joined to the rear face of the vibrator formed in the same substrate as a supporter so that it might be supported in the condition that an end can vibrate freely to a supporter, and said substrate, and said insulating substrate, and has a piezoelectric device. In the gyroscope sensor which vibrates said trembler in the thickness direction by said piezoelectric device Said vibrator formed by using said substrate as a silicon substrate and preparing the penetration section in said substrate by etching, Slot established in said trembler with which the slant face was formed in the front face of said silicon substrate of anisotropic etching Gyroscope sensor characterized by having the distorted detection means which used the electrodeposted resist for said slant face of said slot, and was formed in it.
3. In Video Camera with which Gyroscope Sensor Which Vibrates Trembler in the Thickness Direction by Piezoelectric Device was Carried Substrate fixed to the lens section of said video camera Said vibrator formed by etching said substrate and preparing the penetration section, The slot where the pair syncline side was formed in said trembler of anisotropic etching, **** manual stage which used the electrodeposted resist inside said pair syncline side of said slot, and was formed in it Video camera characterized by having the thin film electrode which detects the electrical potential difference which it is prepared in said substrate and produced for said distorted detection means.
4. It is Joined to Underside of Insulating Substrate Joined to Rear Face of Vibrator Formed in the Same Substrate as Supporter so that it Might be Supported in the

Condition that it Can Vibrate Freely, and Said Substrate, and Said Insulating Substrate, and Has Piezoelectric Device. In the manufacture approach of a gyroscope sensor of vibrating said trembler in the thickness direction by said piezoelectric device The process which etches said substrate, prepares the penetration section and forms said vibrator, The process which forms the slot which has a pair syncline side by anisotropic etching in said formed trembler, The manufacture approach of the gyroscope sensor characterized by having the process which applies an electrodeposted resist inside said pair syncline side, and the process which forms a distorted detection means inside said pair syncline side using said applied electrodeposted resist.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
A gyroscope sensor and video camera technical field using it This invention is suitable for the video camera with a blurring prevention function using the oscillating-type gyroscope sensor and it which especially a beam-like trembler is vibrated and detect the Coriolis force according to angular velocity about the device using the gyroscope sensor and it which detect angular velocity, and a camera device.
Background technique As an oscillating-type gyroscope sensor whose price applied the micro-machining technique, and miniaturized and fell, the thing of a publication is known by JP,6-288774,A, for example.
This oscillating-type gyroscope sensor has the composition of detecting the amount of deflections of the vibrator arranged in the center by vibrator and two electrostatic-capacity change inter-electrode [for detection]. The process tolerance of the polar zone and inter-electrode electrostatic capacity are large to detection sensitivity, and the above-mentioned conventional technique influences in order to read vibrator and two inter-electrode electrostatic-capacity change as the detection approach of the Coriolis force.
Moreover, in order to raise the sensibility of a sensor, it is necessary to make an inter-electrode narrow gap into homogeneity, and to process it with high process tolerance with sufficient repeatability. Furthermore, area of the polar zone must be enlarged and electrostatic capacity must be increased so that the rate of electrostatic-capacity change may not become small under the effect of the stray capacity of the circumference of wiring.
Furthermore, it is difficult ****** to form minute spacing of 5 micrometers or less for gap spacing with homogeneity and sufficient repeatability in a wafer side, even if it uses the anisotropic etching of silicon although penetration etching of the silicon must be carried out for forming the polar zone.

Furthermore, for enlarging area of the polar zone, vibrator must be made into slender structure, the resonance frequency of vibrator will fall and, as for this, detection sensitivity will fall.
The object of this invention solves the technical problem of the above-mentioned conventional technique, and is miniaturized, detection sensitivity is high and the variation in sensibility aims at providing the video camera list using a small gyroscope sensor and small it with the manufacture approach of a gyroscope sensor.
Disclosure of invention This invention forms a distorted detection means in the slant face of the slot which is joined to the underside of the insulating substrate joined to the rear face of the vibrator formed in the same substrate as a supporter, and a substrate, and an insulating substrate, has a piezoelectric device so that it may be supported in the condition that an end can vibrate freely to a supporter, and has the slant face established in vibrator in the gyroscope sensor which vibrates vibrator in the thickness direction by the piezoelectric device, and a slot.
Thereby, a trembler can form a substrate easily by anisotropic etching etc., and since the amount of deflections of a trembler is detectable through a distorted detection means on the slant face of the slot established in the trembler, big output voltage is obtained by taking the differential output voltage of each distorted detection means. And thickness of a gyroscope sensor is made thin and the whole can be miniaturized.
Moreover, it is joined to the underside of the insulating substrate joined to the rear face of the vibrator formed in the same substrate as a supporter so that it might be supported in the condition that an end can vibrate freely to a supporter, and said substrate, and said insulating substrate, and this invention has a piezoelectric device. In the gyroscope sensor which vibrates said trembler in the thickness direction by said piezoelectric device Said vibrator formed by using said substrate as a silicon substrate and preparing the penetration section in said substrate by etching, It has the distorted detection means which used the electrodeposted resist for the front face of said silicon substrate, and was formed in said slant face of the slot prepared at said trembler with which the slant face was formed, and said slot of anisotropic etching on it.
Furthermore, this invention is set by the piezoelectric device to the video camera with which the gyroscope sensor which vibrates a trembler in the thickness direction was carried. The silicon substrate fixed to the lens section of a video camera, and the vibrator formed by etching a silicon substrate and preparing the penetration section, It has the distorted detection means which used the electrodeposted resist inside said pair syncline side of the slot in which the pair syncline side was formed of anisotropic etching, and a slot, and was formed in the trembler, and the thin film electrode which detects the electrical potential difference which it is prepared in a silicon substrate and produced for a distorted detection means.
Since thickness of a gyroscope sensor can be made thin, while being able to miniaturize as the whole video camera by this, mounting, such as wiring processing to the video

camera of a gyroscope sensor, can be made easy.
Furthermore, it is joined to the underside of the insulating substrate joined to the rear face of the vibrator formed in the same substrate as a supporter so that it might be supported in the condition that it can vibrate freely, and said substrate, and said insulating substrate, and this invention has a piezoelectric device. In the manufacture approach of a gyroscope sensor of vibrating said trembler in the thickness direction by said piezoelectric device The process which etches said substrate, prepares the penetration section and forms said vibrator, The process which forms the slot which has a pair syncline side by anisotropic etching in said formed trembler, It has the process which applies an electrodeposted resist inside said pair syncline side, and the process which forms a distorted detection means inside said pair syncline side using said applied electrodeposted resist, and a distorted detection means is formed.
Thereby, the manufacture approach of a gyroscope sensor should be made easy and precision should be highly suitable for mass production.
Easy drawing 1 of explanation of a drawing is a perspective view showing the gyroscope sensor in one example of the invention in this application.
Drawing 2 is a perspective view showing the appearance when separating the gyroscope sensor of drawing 1 for every substrate.
Drawing 3 is a sectional view showing the A-A' cross section of drawing 1 typically.
Drawing 4 is a sectional view showing the B-B' cross section of drawing 1 typically.
Drawing 5 is a sectional view for explaining the detection approach of the Coriolis force of one example of the invention in this application.
Drawing 6 is a block diagram showing the circuitry of one example of the invention in this application.
Drawing 7 is a sectional view of the vibrator in which other examples of the invention in this application are shown.
Drawing 8 is a top view showing the substrate with which the vibrator of one example of the invention in this application was formed.
Drawing 9 is a top view showing the substrate with which the vibrator of other examples of the invention in this application was formed.
Drawing 10 is a sectional view showing the manufacture approach of one example of the invention in this application.
Drawing 11 is a perspective view of the gyroscope sensor in which other examples of the invention in this application are shown.
Drawing 12 is a perspective view showing the conventional gyroscope sensor.
Drawing 13 is a perspective view showing the appearance of the video camera which mounts the sensor of one example of the invention in this application.
Drawing 14 is a perspective view showing typically the appearance of the lens section by one example of the invention in this application.
Drawing 15 is a top view showing the loading substrate of the gyroscope sensor by one

example of the invention in this application.
The best gestalt for inventing The gyroscope sensor of the oscillating type used for a video camera etc. is low in own height of a sensor, and needs to make occupancy area of a sensor small. Moreover, a biaxial angular velocity must be detected to blurring prevention, and two sensors are also needed.
Hereafter, one example of this invention is explained to a detail with reference to a drawing. The perspective view showing an appearance when the perspective view showing the appearance of a gyroscope sensor [in / in drawing 1 / one example] and drawing 2 separate the gyroscope sensor of drawing 1 for every substrate, The sectional view showing [3] the A-A' cross section of drawing 1 typically, the sectional view showing [4] the B-B' cross section of drawing 1 typically, A sectional view for drawing 5 to explain the detection approach of the Coriolis force of one example, the block diagram showing [6] the circuitry of one example, and drawing 7 The sectional view of the vibrator in which other examples are shown, the top view showing [8] the substrate with which the vibrator of one example was formed, The top view showing the substrate with which the vibrator of the example of others [drawing / 9] was formed, the sectional view showing [10] the manufacture approach of one example, The perspective view showing the example of others [drawing / 11], the perspective view showing [12] the conventional example, and drawing 13 The perspective view showing the appearance of the cut model which cut some video cameras which mount two sensors of one example, the perspective view showing typically the appearance of the lens section according [drawing 14] to one example, and drawing 15 are top views of the loading substrate by one example.
In addition to this in drawing 13, 131 is constituted from the camera section 132, the voice input section 133, and the finder section 134 by the video tape applied part. Drawing is cut in part, and shows the camera section 132, and the lens section 135 and the gyroscope sensor loading substrate 136 are arranged.
In drawing 14, the gyroscope sensor 141 for horizontal blurring detection and the gyroscope sensor 142 for perpendicular direction blurring detection are mounted on the gyroscope sensor loading substrate 136. It is fixed to the lens section 135 by a screw stop etc., and the loading substrate 136 is united.
Since the loading substrate 136 also moves simultaneously that the lens section 135 is horizontal and when it moves perpendicularly, the angular acceleration of each direction is detected by sensors 141 and 142.
As for sensors 141 and 142, in drawing 15, it is desirable from points, such as sensibility and precision, to arrange in the location possible nearest to the lens optical axis 152 of the lens outer-diameter location 151. However, since both a sensor 141 and the sensor 142 are gyroscope sensors of an oscillating type, about 500Hz has been shifted so that the resonance frequency may not be resonated mutually.
The package section and the amplifying-circuit section are omitted in drawing 1. The

gyroscope sensor consists of three kinds of substrates, the piezo-electric substrate 1 of the bulk which is a piezoelectric device, the glass substrate 2 for an insulation which is an insulating substrate, and the silicon substrate 3 which forms vibrator, and each is joined. The thickness of the magnitude of a gyroscope sensor is about 2mm in about 4x14mm.

Field bearing of a silicon substrate 3 is {100}, the silicon opening 9, i.e., the penetration section, is formed by the anisotropic etching of silicon, and the slot 5 which has a pair syncline side by anisotropic etching in the trembler 4 used as a cantilever is formed. Anisotropic etching of silicon is performed using alkali system etching reagents, such as a potassium-hydroxide water solution (KOH) and a tetramethylammonium hide low key site (TMAH).

Moreover, the piezo-electric thin film 6 and the piezo-electric thin film 7 for feedback which consist of ZnO for detection as its its distorted detection means are formed in the medial surface and base of a pair syncline side of a slot 5. [of a slot] In order to detect the electrical potential difference produced in these piezo-electric thin films, laminating patterning is carried out so that the GND electrode 10 may put both the piezo-electricity thin film as the thin film electrode 8 and a common electrode.

The thin film electrode 12 for a piezo-electric substrate drive for making stretching vibration carry out in the direction of X to the piezo-electric substrate 1 is formed in both sides. If the electrical potential difference of the frequency in this electrode is impressed, the piezo-electric substrate 1 will vibrate on that frequency, and the vibrator 4 formed in the silicon substrate 3 is excited in the direction of X.

Moreover, a glass substrate 2 is for making it the electrode 12 of a silicon substrate 3 and the piezo-electric substrate 1 not short-circuit, and the glass crevice 11 is formed further.

The glass crevice 11 is formed so that vibrator 4 may not contact a glass substrate 2. Since vibrator is formed using the anisotropic etching of silicon, the cross-section configuration of opening 9 is a configuration of a back taper, and the cross-section configuration of vibrator 4 is the U character mold configuration of a back taper by bilateral symmetry.

The cross-section dimensions of vibrator are a:350 micrometers of abbreviation, b:200 micrometers, c:900 micrometers, and d:1300 micrometers, the piezo-electric thin film 6 is formed in the pair syncline side where the slot 5 of vibrator 4 faces each other, the piezo-electric thin film 7 for feedback is formed in the base of a slot 5, and patterning of the piezo-electric thin films 6 and 7 is carried out, without being connected mutually.

Next, drawing 5th [the] and 6 explains the angular-velocity sensing approach of an oscillating-type gyroscope sensor. While the vibrator 4 of mass m is vibrating at a rate v in the direction of X with the piezo-electric substrate 1, when angular velocity omega joins the circumference of the Z-axis, the Coriolis force F according to angular velocity (= 2mvomega) occurs. Since the Coriolis force is added in the direction of Y, vibrator 4

becomes the synthetic oscillation of a deflection, the direction of X, and the direction of Y in the direction of Y.
This amount of deflections is detectable as electrical-potential-difference change of the piezo-electric thin film 6 formed in the slot 5 by ZnO and the piezo-electric thin film 7.
Drawing 5 is an explanatory view of operation at the time of the nonrotation which angular velocity has not joined, and the revolution which angular velocity joined, and while vibrator 4 is vibrating in the direction of X by the rate v and Force f, vibrator 4 oscillates flexurally in the direction of X. Therefore, in two piezo-electric thin films 6, distortion by f arises in the excitation direction and the same direction.
When the decomposition component of Force f is added in the direction of thickness of the piezo-electric thin film 6, the output voltage value generated in the piezo-electric thin film is set to A1. Next, angular velocity joins the circumference of the Z-axis, and, as for vibrator 4, the Coriolis force F vibrates in the resultant-force direction of f and F in the direction of drawing at the time of ************ (at the time of a revolution).
And the electrical-potential-difference value produced by the Coriolis force F is set to A2. Therefore, the output voltage value generated in each piezo-electric thin film 6 for detection by the decomposition component of resultant force being added in the direction of thickness of the piezo-electric thin film 6 is set to A1-A2 and A1+A2, respectively. The absolute value of these differential-output-voltage values is set to two A2, and an electrical potential difference twice the output voltage value of producing in each piezo-electric thin film by the Coriolis force F can be obtained.
Force f and the output from the piezo-electric thin film 6 obtained by synthetic oscillation with the Coriolis force F are inputted into the differential amplifying circuit 14 with a built-in filter as shown in drawing 6, cut the disturbance component of a sensor and take out the electrical-potential-difference value by the Coriolis force F. And while vibrating the piezo-electric substrate 1 simultaneously in an oscillator circuit 13, with the piezo-electric thin film 7 formed in vibrator 4, the monitor of the oscillation frequency is carried out, it feeds back to an oscillator circuit 13, and a frequency is adjusted. The signal pass the differential amplifying circuit 14 on the basis of this frequency is detected by the synchronous-detection circuit 15. Furthermore, the detected electrical-potential-difference value is amplified by the direct-current amplifying circuit 16, and it takes out as a signal by the Coriolis force. Detection of angular velocity is performed by the above.
Next, drawing 7 explains other examples of the cross-section structure of vibrator 4. It will be (b) (c) if the anisotropic etching of silicon is used to (a) explained in the one example,
It can do, also as shown in (d).
In (a), the U character mold structure of vibrator 4 is made from performing anisotropic etching from the side front of a silicon substrate 3, forming a slot 5, performing anisotropic etching from a rear face after that, and forming opening 9.

When in (b) performing anisotropic etching from a side front and forming a slot 5, the part made to penetrate beforehand is etched to some extent, and vibrator 4 can be formed by performing anisotropic etching and making it penetrate from a rear face after that. The amount of etching from the rear face at this time is made few compared with the case of (a).

In (a) and (b), the piezo-electric thin film 7 is not necessarily required. However, since the way in which the piezo-electric thin film 7 was formed can feed back the signal by the piezo-electric thin film 7 to an oscillator circuit 13 as explained in drawing 6, it becomes possible to adjust a frequency, and it is more highly precise and can consider as high sensitivity.

Next, in (c), cross-section structure of vibrator 4 is used as a V character mold, the piezo-electric thin film 7 is not formed, but simplification is in drawing.

(d) is what extended the type of (a) and it is possible to form two slots 5 and to raise detection sensitivity compared with (a).

Drawing 8 and drawings 9 are other examples of vibrator 4. When the cross-section configuration of vibrator 4 is (a) of drawing 7, the configuration on the rear face of a table of a silicon substrate 3 is shown in drawing 8. (a) of drawing 8 shows the shape of surface type of a silicon substrate 3, and (b) shows the rear-face configuration of a silicon substrate 3.

Since field bearing is {100}, if a silicon substrate 3 performs anisotropic etching, as shown in (b), the taper slant face of the {111} silicon crystal face 17 will be formed.

Moreover, the Coriolis force F is so large that the rate of an oscillating object is so quick that the mass of an oscillating object is large. For that purpose, as shown in drawing 9, the weight part 18 may be formed at the head of vibrator 4. Since the large excitation amplitude can be taken by this since the head of vibrator 4 becomes heavy, and the deflection of the vibrator by the Coriolis force F also increases, the electrical potential difference generated in the piezo-electric thin film 6 becomes large, and sensibility improves.

Next, drawing 10 explains the manufacture process of vibrator 4 that the piezo-electric thin film 6 and the piezo-electric thin film 7 were formed, in order of (a) - (g).

(a): Form a slot 5 in the front face of the silicon substrate 3 of field bearing {100} by anisotropic etching. Anisotropic etching is performed using alkali system etchant (KOH), for example, a potassium-hydroxide water solution, and a tetramethylammonium hide low key site (TMAH). Next, it oxidizes thermally and SiO2 film 19 is formed in a silicon substrate 3. Furthermore patterning of the SiO2 film on a side front is carried out, and SiO2 pattern 20 is formed.

(b): Form chromium and the lower layer electrode 21 formed with the golden two-layer thin film on the side front of a silicon substrate 3 by vacuum deposition or the spatter.

(c): Next, apply a resist to a substrate using the electrodeposted photosensitivity resist by which coating is carried out by electrophoresis. Furthermore, patterning of the lower

layer electrode 21 is carried out through a HOTORISO process, and the lower layer electrode pattern 22 is obtained.
(d): Carry out sequential membrane formation of the piezo-electric thin film 23 of ZnO, and the upper electrode 24 by the spatter so that the lower layer electrode pattern 22 may be covered. The upper electrode 24 here is formed with the two-layer thin film of the same chromium as the lower layer electrode 21, and gold. In addition, conductive thin films, such as an aluminum thin film, can also be used.
(e): Apply a resist to a substrate front face using an electrodeposted (photosensitivity) resist. Patterning of the upper electrode thin film 24 and the ZnO thin film 23 is carried out through a HOTORISO process similarly after that, and the upper electrode pattern 26 and the ZnO thin film pattern 25 are obtained. The ZnO thin film pattern 25 and the upper electrode pattern 26 are formed in the slant face of the anisotropic etching slot 5. The electrodeposted resist was used by the process (c) and (e) because the side face and base of a slot 5 were covered by the resist also in the case of the deep groove where a slot 5 exceeds 100 micrometers.
(f): Carry out patterning of the SiO2 film 19 on the back, and form the rear-face Si opening 27.
(g): Cover the front face of a substrate 3 so that etchant may not sink in using a fixture, perform anisotropic etching by KOH from a rear face, and form the penetration section. Under the present circumstances, you may etch into a front face by forming SiO2 thin film first.
Next, drawing 11 explains the oscillating-type gyroscope sensor which can detect an angular velocity biaxial with one component as other examples. In this example, since a biaxial angular velocity is detected, the gyroscope sensor arranged two pieces can be unified, and it is much more advantageous to a miniaturization.
The thing of a basic configuration of drawing 11 is the same as that of drawing 1, and two are formed so that an oscillating beam may cross a right angle mutually through the glass substrate 2 for an insulation on the piezo-electric substrate 1. And others of one are the vibrator 29 for the circumference angular-acceleration detection of a Y-axis in the vibrator 28 for the circumference angular-acceleration detection of the Z-axis. It is determined that the dimension of each part, a location, etc. shift the resonance frequency of these vibrator beforehand so that it may not interfere mutually.
Moreover, the piezo-electric thin films 30 and 32 and the ZnO thin films 31 and 33 for detection are formed in each, and angular-velocity detection of a Y-axis and the Z-axis is performed to it like the case of drawing 1.
Although the above-mentioned example forms the piezo-electric thin film in the slant face of a slot as a distorted detection means, a distorted detection means is not restricted to a piezo-electric thin film, and the same effectiveness is expectable even if it sticks a bulk piezo electric crystal on the slant face of a slot.
According to this invention, it is miniaturized, and detection sensitivity is high and can

acquire the manufacture approach of a gyroscope sensor in the video camera list using a gyroscope sensor and it with the small variation in sensibility. Furthermore, the following things can specifically be said.
(1) It can manufacture with a micro-machining technique, and a configuration is easy and rich in mass production nature.
(2) Since it consists of junction substrates by three layers, a piezoelectric device, an insulating substrate, and the substrate of vibrator, even if thickness is thin, the occupancy area of a sensor is small, a miniaturization and compound-izing are possible and it installs more than one in a video camera, don't take a large tooth space.
(3) Since a slot is established in vibrator and the piezo-electric thin film which is a distorted detection means is prepared in the medial surface which the slot counters, while being able to press down cost, configuration dispersion between components can be pressed down, and dispersion in the output sensibility of a sensor can be pressed down.
(4) Since output dispersion between sensors can be pressed down, if this sensor is mounted in a video camera etc., addition of the amendment circuit for adjusting sensor sensibility at the after process after mounting or the software for control will become unnecessary.